FLAAR Reports

Professor Nicholas Hellmuth and James Zubricky

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Laser Engraving with the Universal M-300 Laser System

FLAAR Reports

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Caption for front cover:
The Universal M-300 Laser System available at the Center for Applied Technology at Bowling Green State University

Introduction

Imagine taking a digital photograph, and instead of printing it out on photo paper, you get an etching of that photograph in wood, on a metal, or a plastic!

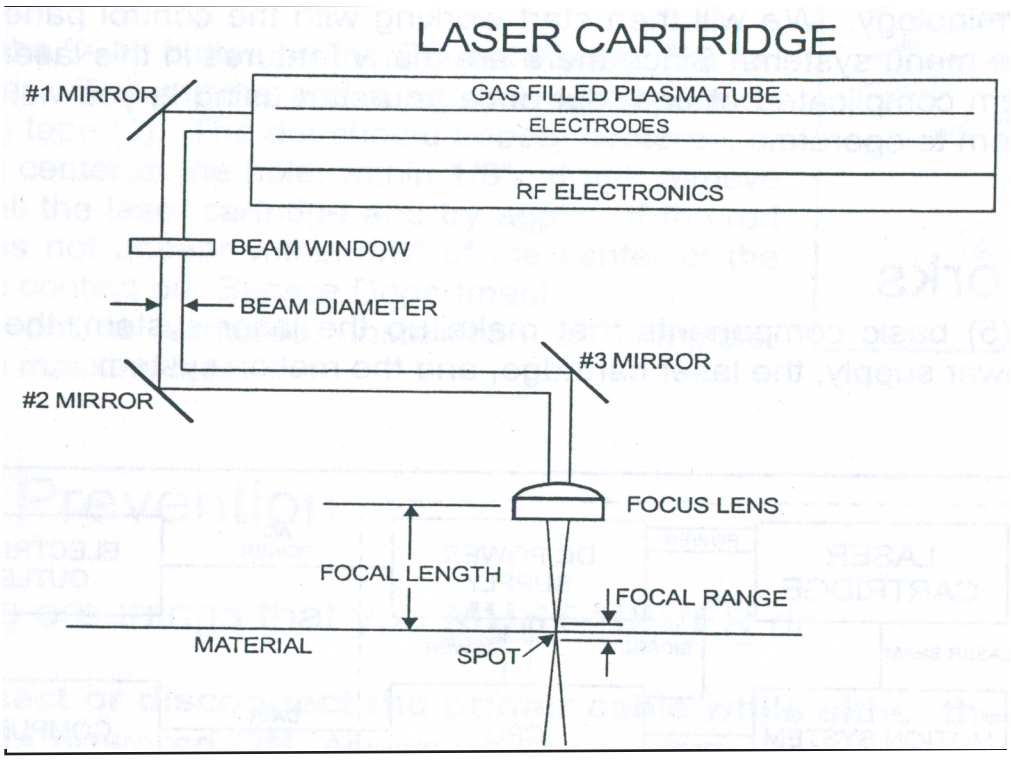
With the M-300 Laser Engraver (manufactured by Universal Laser Systems Inc.) located at Bowling Green State University's Center for Applied Technologies, all of this is possible, and more.

Laser engraving is defined as "the practice of using lasers to engrave, etch, or mark an object" (from Wikipedia.com). While laser engraving systems are more expensive than machines that use tool bits to engrave, laser engraving systems are considered to be better than those machines because they do not have parts that wear out from usage and have to be replaced on a regular basis.

Most laser engraving systems have three main parts: the laser itself, the controller, and the materials being engraved.

The Laser

The main goal of any laser is to convert electrical energy into light energy. In fact, the word laser is an acronym for light amplified stimulated emission of radiation. The laser cartridge inside the M-300 laser engraver consists of a gas-filled plasma tube that is filled with a mixture of carbon dioxide (CO_2) and other gases as well as radio frequency electronics and electrodes. When the laser is told by the controller to start, it receives a signal from the radio frequency electronics, which then sends a signal to the electrodes inside the plasma tube. The electrodes, in turn, begin to excite the gaseous mixture in the plasma tube. When this happens, the gases inside the plasma tube become excited and begin emitting particles of light called photons. These photons combine to make an infrared beam of light. Because it's infrared, we can't see it with our naked eye; the only thing we can see, however, is when the laser is striking the surface of an object. The laser beam then exits the laser cartridge and



Schmatic diagram of the Universal M-300 Laser System's laser cartridge. [Diagram from "M-300 Laser Platform: Installation and Operations Guide." Scottsdale, AZ: Universal Laser Systems Inc., 2000.]

bounces off of the first mirror to pass through the beam window, then hits mirrors 2 and 3 and finally passes through the focus lens. Mirrors 2, 3, and the focus lens are mounted to the motion system which moves about the surface of the object. While the job of the mirrors is to direct the laser beam to the spot on the surface to be engraved, the job of the beam window is to control the diameter of the laser beam (which should be 4 mm), and the job of the focus lens is to essentially focus the beam into a very small spot size. This spot size is then dependent on the length of the laser beam between the focus lens and the surface of the object. The image on the previous page is a schematic diagram of how the laser cartridge system for the Universal M-300 Laser System works.

The laser engraver in action: burning an image of hieroglyphics onto a piece of plywood.

The Cartridge

The controller of the laser engraver system is comprised of two computers: the user computer is where the actual design that the laser engraver will make and the other is a computer processing unit inside the laser engraver.

The CPU inside the laser engraver is the central nervous system of the entire machine. The incoming files from the user computer are sent here and are stored while the laser engraver is on. Also, the CPU sends output messages to the laser cartridge that tells when to fire as well as directing the motion system to move about the laser table.

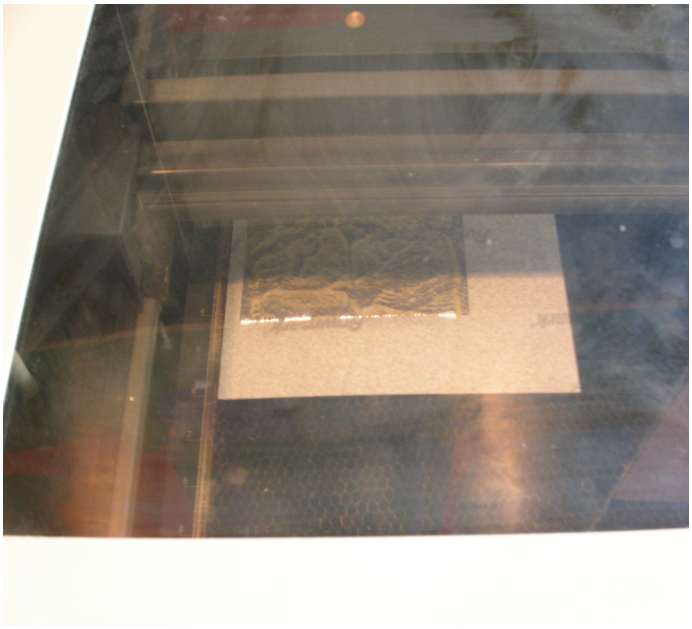
The user computer is where files are created and sent to the CPU inside the laser engraver to be printed. Here is also where the direction, speed, and spread of the laser can be edited and changed, primarily depending on the type of surface that is being engraved. Essentially any graphic editing program, like Adobe Illustrator or Adobe Photoshop (www.adobe.com) can be used to create images that will be laser engraved. Within the "Print Setup" commands of these programs, you can edit the speed, as well as the style of engraving.

There are two types of engraving that the laser engraver gives the user: raster and vector engraving. In raster engraving, the motion system will move in a back-and-forth motion that's similar to how an inkjet printhead moves across a sheet of paper. On the other hand, vector engraving requires the motion system to follow the lines and the curves of the pattern and basically makes darker lines. Essentially, vector engraving is used to cut parts out; raster engraving is used to fill or shade in an object.

Materials Used for Engraving

The following materials can be engraved upon using the M-300 laser engraver:

- Acrylic
- Aluminum
- Brass
- Cork
- Corian / Avonite / Fountainhead
- Delrin (seal press)
- Glass / Crystal
- Leather
- Marble
- Mat board
- Melamine
- Plastic
- Rubber stamps
- Vinyl – sign (3 mil)
- Wood / Wood inlay



The laser engraver can engrave on (almost) any surface; in this case, the engraver is working on a plastic. Be sure to read the instruction manual before using the system with any sort of plastic.

The users manual for the M-300 laser engraver goes into great detail about how the printer driver's settings should be at when using certain types of materials. However, the general rule of thumb concerning the power and the speed of the machine are as follows: doubling the power of the laser doubles the depth of the cut, and doubling the speed of the laser halves the depth of the cut.

There is also a smell factor that comes into play when engraving on any sort of surface. Because the laser is cutting into the surfaces of objects, the objects will emit a smell of some type. It is imperative, therefore, that an exhaust system needs to be installed and operating whenever the laser engraver is going to be used. Some plastics like, polyvinylchloride (PVC) emit toxic fumes when engraved upon, which will do serious damage to the person using the engraver, as well as others in the room. It is important for the operator to follow all safety concerns when using the laser engraver.

Safety Concerns with the Universal M-300 Laser Engraver

There are four major safety concerns with the laser engraver that must be addressed every time it is being used:

1. The laser engraver must constantly be monitored while in use, especially since the laser can ignite combustible materials.

2. The laser engraver must be used with a properly installed and functioning exhaust system. Some of the materials used for engraving can give off toxic fumes that may linger for minutes (or hours) after the engraving project is done, and breathing these fumes can be hazardous to your health.

3. The laser engraver must not engrave or cut materials made of polyvinylchloride (PVC). The fumes are extremely toxic and will chemically destroy the metal parts of the laser system.

4. The laser engraver cannot engrave upon uncoated metals or reflective surfaces; the laser beam will be reflected off of these metals, which will cause damage to the laser system.

Possible Applications with the Laser Engraver

There are many different possible applications with the M-300 laser engraver:

- Models of buildings
- Sculptures can be etched in wood or marble
- Awards and plaques
- Laser drilling through hard materials like ceramics, silicon, and diamond
- Rubber stamps
- Letter or graphic templates
- Name tags and pet tags
- Industrial ID tags of products
- Personalization of electric guitars

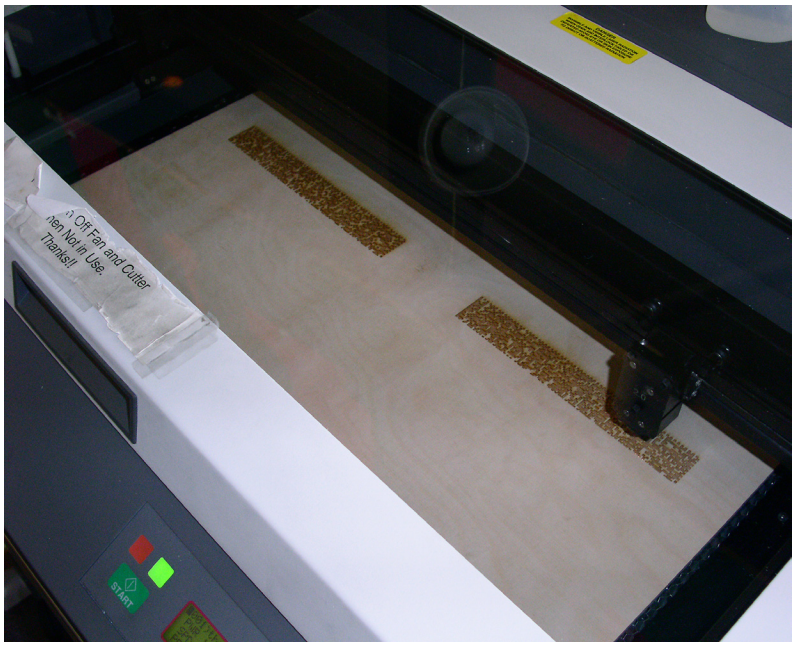
There are many more applications than the ones listed here; Universal Laser Systems, Inc. has a very good website (http://www.ulsinc.com/english/laser_applications/laser_apps.html) that shows the possibilities of products created with laser engraving.

Professor Nicholas Hellmuth discussing laser engravers with representatives from Universal Laser Systems during a recent convention.

Additionally, students at Bowling Green State University have used the Universal M-300 Laser System for their classes; classes that extensively use the laser engraver range from architecture and technology classes offered by the College of Technology to digital arts students from the School of Fine Arts.

Websites of Interest and Sources of Information

http://www.epiloglaser.com/index.htm
Epilog Lasers, located in Golden, Colorado, is another manufacturer of CO2 laser engravers. What is really cool (for the newbie to laser engraving) is a website that helps users determine which system is the best to purchase in terms of engraving size and types of materials that will be engraved.



The laser engraver at work: it can engrave more than one object at the same time.

http://www.oxfordlasers.com/micro-machining_applications.htm
Oxford Lasers (in Littleton, MA) has a very good website that shows the application of laser engravings. Their specialty is to do very small drilling (one-millionth of a meter) for hard materials like ceramics or even diamonds. Their website also features electron micrographs of their work.

http://www.omegalaser.com/
Omega Laser Systems (located in the Netherlands) primarily service the industrial needs for laser engraving. They also have photos of machines currently in their laboratory, as well as some of the industrial applications that they have done for companies.

www.trotec.net
Trotec (with its' worldwide headquarters located in Austria, and an office in Detroit, MI) manufactures both CO_2 and Nd:YAG lasers, and also a "hybrid" laser that combines the properties of both the CO_2 and the Nd:YAG lasers. Their website also features many, many examples of laser engraving, laser cutting, and laser marking. This website is definetly worth a look.

http://www.ulsinc.com/english/index.html
Universal Laser Systems, Inc. is the manufacturer of the laser engraver that we currently have available at the Center for Applied Technology. They also have starter kits of materials available for people who want to try different media.

Two BGSU students using the Universal M-300 Laser System at the Center for Applied Technology at Bowling Green State University.

Conclusion

As you may surmise from this FLAAR Report, we have developed an interest in laser engraving technology. The reasons for our developed interest in this field are four-fold:

- laser engraving technology can assist museums;

- laser engraving machines are useful for architects and architectural students;

- laser engraving machines are useful for the faculty and students in both the College of Technology and the School of Fine Arts on the campus of Bowling Green State University;

and, lastly,

- laser engraving machines can be helpful to archaeologists to re-create ancient artifacts.

FLAAR is a research and educational institute dedicated to learning which digital imaging technologies can assist scientists in their studies of ancient Mesoamerican civilizations of Latin America. Building on this interest, we wish to provide educational materials to the general public so that others can benefit from what we have learned in our research. Thus, for example, a museum with a large collection of artifacts and/or artwork could use a laser engraver to reproduce works of incised or bas-relief sculpture to sell in their museum store. This would bring in badly-needed revenue that could help the museum stay afloat. Nowadays museums and university departments have plenty of wide format inkjet printers. FLAAR is suggesting, through this report, that museums and university departments should highly consider acquiring laser engraver technology as well.

Archaeologists and epigraphers could use the highly-powered laser engravers and cutters to re-create ancient Mayan sculptures with hieroglyphic inscriptions.

However, if people don’t know about this technology, they won’t realize that they should start to learn more about the possibilities of this technology. On top of this FLAAR report, readers should tro try to visit a local distributor or other comparable place that can show them the actual laser engraver machines.

The following images were the result of the "test drive" of the Universal M-300 Laser System at Bowling Green State University.

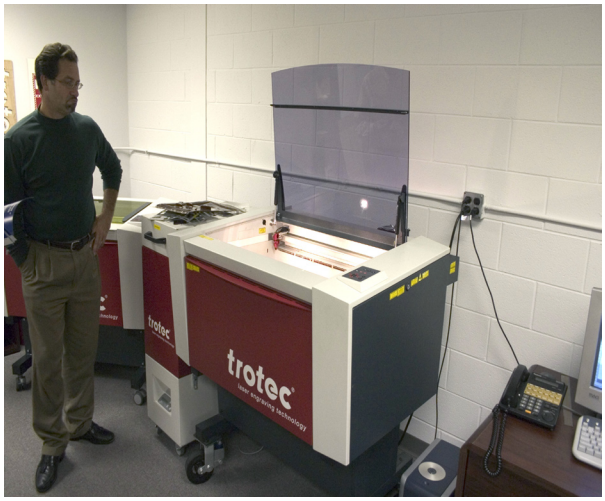
A Mayan sculpture used to "test drive" the M-300 Laser System

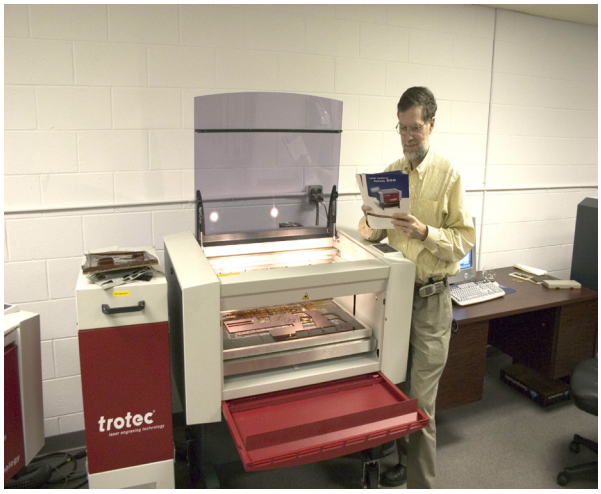
The same sculpture engraved in a plastic

The same sculpture engraved in wood (after changing the contrast of the original graphic).

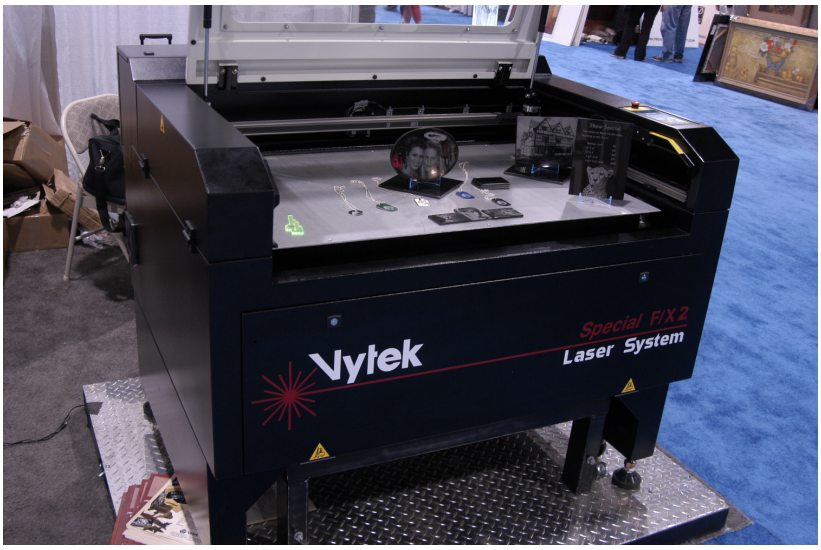
The same sculpture engraved in plywood with no changes made to the contrast.

The following images were taken by Dr. Nicholas Hellmuth and Mr. Brent Cavanaugh, both of Bowling Green State University, during a recent site-visit to Trotec's regional office near Detroit, Michigan.





These photos are shots of the Vytek Laser System booth at the 2005 Atlanta Art Expo.



The following are images (shot by staff member Angela Bertke) of the Universal Laser Booth at both the 2005 Atlanta Art Expo and the 2005 Viscom Dusseldorf show.